1.1 States separation and atoms

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

Objective

Build the skills to answer exam questions on **states of matter, separation and atomic structure** 、 : particle arrangements and changes of state, separating mixtures, chromatography, atoms, isotopes and the Periodic Table.

You must be able to:

- describe particles in solids, liquids and gases
- choose a method to separate a mixture and calculate R_f values
- work out protons, neutrons, electrons and electronic configurations
- calculate relative atomic mass from isotope abundances

1 Key knowledge and worked examples

■ Separation and atoms

idea	rule or formula
R_f value	distance moved by the spot ÷ distance moved by the solvent front
protons	atomic number
neutrons	mass number − atomic number
electron shells	fill in the order 2, 8, 8; the group is the number of outer electrons
relative atomic mass A_r	(abundance × mass number, added for each isotope) ÷100

Worked example 1: relative atomic mass. Boron is 19.9% boron-10 and 80.1% boron-11. Find A_r.

1. Known: 19.9% of 10; 80.1% of 11.
2. Rule: (abundance × mass, added) ÷100.
3. Numbers: $(19.9 \times 10 + 80.1 \times 11) \div 100 = (199 + 881.1) \div 100$.
4. Result: 10.8.

Worked example 2: an atom. Chlorine-37 has atomic number 17. Find its protons, neutrons, electrons and configuration.

1. Known: atomic number 17; mass number 37.
2. Rule: protons = electrons = 17; neutrons = 37 − 17.
3. Numbers: 20 neutrons; 17 electrons fill $2, 8, 7$.
4. Result: 17 **p,** 20 **n,** 17 **e,** 2.8.7 (Group 7).

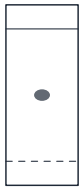
Answer shapes: for separation, name the method **and** say which property it uses (solubility, boiling point, particle size).

2 Practice

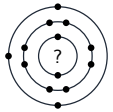
2.1 Describe the arrangement and the movement of the particles in a gas. [2]



2.2 On a chromatogram a spot moves 4.5 cm and the solvent front moves 9.0 cm. Calculate the R_f value. [2]



2.3 An atom has 13 protons. State its electronic configuration and its group. [2]



2.4 Name the method to get: salt crystals from salt solution; pure ethanol from a mixture of ethanol and water. [2]

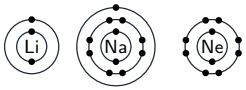


3 Exam-style questions

3.1 Gallium is 60% gallium-69 and 40% gallium-71. Calculate the relative atomic mass of gallium. [3]

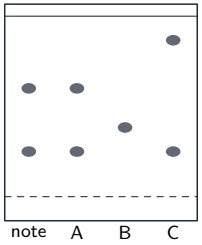
isotope	abundance
gallium-69	60%
gallium-71	40%

3.2 Explain why elements in the same group have similar chemical properties, and why Group 0 elements are unreactive. [3]



3.3 A scientist tests the black ink on a note against the inks of three pens, A, B and C. The chromatogram is shown. The solvent front moved 8.0 cm. The two spots from the note moved 2.0 cm and 4.8 cm.

(a) Calculate the R_f values of the two spots from the note, and state which pen matches. [3]



(b) Describe how the scientist should set up this chromatography experiment. [4]

(c) Explain why the start line is drawn in pencil, not in ink. [3]

(d) The scientist wants pure water from a solution of the ink. Describe how to obtain pure water from the solution, and how to show that the water is pure. [6]

Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- far apart, randomly arranged
- move quickly in all directions

2.2

- $4.5 \div 9.0$
- **0.50**

2.3

- 2.8.3
- Group 3

2.4

- crystallisation
- fractional distillation

3.1

- $(60 \times 69 + 40 \times 71) \div 100$
- $(4140 + 2840) \div 100$
- **69.8**

3.2

- elements in a group have the same number of outer-shell electrons
- reactions depend on the outer electrons, so they react in similar ways
- Group 0 atoms have full outer shells, so they do not lose, gain or share electrons

3.3

(a) $2.0 \div 8.0 =$ **0.25**; $4.8 \div 8.0 =$ **0.60**; pen A

(b) any four (1 mark each):

- draw a start line in pencil about 1 cm from the bottom of the paper
- put small spots of each ink on the line
- stand the paper in a beaker with solvent below the start line
- cover the beaker and leave until the solvent is near the top, then mark the solvent front

(c) pencil (graphite) is insoluble in the solvent, so it does not move or spread; ink would dissolve and give extra spots that confuse the result

(d) points to include:

- use simple distillation: heat the solution in a flask (K)
- water boils and the steam passes into a condenser, where it cools and condenses (K)
- collect the liquid (distillate) in a beaker; the dyes stay in the flask (K)
- the dyes have much higher boiling points than water, so they do not evaporate (An)
- test purity: pure water boils at exactly 100 °C (and freezes at 0 °C) (K)
- an impure liquid boils over a range of temperatures (An)

Levels: **5–6** a full, logical answer with correct chemistry and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.